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EA Report 9092

OPERATIONAL ECOLOGICAL STUDY IN THE CEDAR RIVER NEAR DUANE ARNOLD ENERGY CENTER JANUARY THROUGH DECEMBER 1980

Prepared for

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CONTENTS

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SUMMARY

The 1980 operational monitoring data collected near Duane Arnold Energy Center (DAEC) corresponds with the results of prior operational and preoperational investigations of the Cedar River. The monitoring of the Cedar River revealed minimal variations in water quality immediately downstream from the station discharge and no apparent alterations in the biological communities. The principal factors influencing the chemical, physical and biological parameters of the Cedar River near DAEC were the natural hydrologic and seasonal variations which occurred during 1980.

The operation of DAEC had a minimal effect on the water quality of the Cedar River as indicated by chemical and physical measurements. Temperature, total dissolved solids, total solids, hardness, orthophosphate, and sulfate were the only water quality parameters in the river affected by station operation. Effects on these parameters appeared localized near the discharge as little or no effects were observed one-half mile further downstream. Little variation was found in the levels of general water quality parameters (other than those affected by station operation) and nutrients between river locations for a given sampling event or between annual mean values for each river location. This provided further indication of minimal effect of station effluent on river water quality.

Diatoms were the most abundant component of the phytoplankton community in the Cedar River and in the discharge canal during most of 1980. Phytoplankton densities were highest in late May, and again in late October with lowest densities occurring during the winter. Differences in the phytoplankton community among locations and over time were attributed to natural spatial and seasonal variability and not to the operation of DAEC.

Blue-green algae composed more than half of the periphyton assemblage at both upstream and downstream locations during all sampling periods. Differences in the relative abundance of periphytic taxa between sampling sites were attributed to natural factors (i.e., grazing of substrates by macroinvertebrates). Periphyton biomass production and assemblage composition differences between upstream and downstream locations were not reflective of any perturbation as a result of station operation.

The dominant benthic macroinvertebrates collected from the natural substrate samples in the Cedar River were the rhabdocoel near Macrostromum sp. and the Chironomidae or midge fly larvae. The benthic community was generally sparce and contained relatively few taxa at all locations during 1980. Aquatic Oligochaeta and the insect orders Ephemeroptera, Plecoptera, Trichoptera and Diptera were the dominant organisms that colonized the artificial substrate samplers in the Cedar River. The diversity and density of the organisms colonizing artificial substrate samplers were generally greater than the fauna collected from natural substrates. This difference was attributed to the favorable stable substrate of the Hester-Dendy samplers as opposed to the unstable sand of the river bottom. There were no consistent differences in the macroinvertebrate communities of the natural and artificial substrate samples during 1980 which could be attributed to the operation of DAEC.

The predominant fish species collected by electrofishing were river carpsucker and carp while spotfin shiners were the dominant species collected by seining. Game species were collected in low numbers with all sampling methods. Greater numbers and a greater variety of fish were collected downstream from the station than upstream. No pronounced differences were noted in the food habits of fishes upstream or downstream from DAEC. All fish collected upstream and downstream from the station had low levels of chlorinated insecticides and PCB's. The caged fish study recorded highest mortalities in the discharge canal but there was no evidence that the effluent from the discharge canal adversely affected fish in the downstream river location. The results of this study did not provide evidence that the operation of the DAEC adversely impacted the fish community of the Cedar River.

Only 230 fish were impinged at the DAEC during 1980. More than two-thirds of the impingement occurred during January and February. Young-of-the-year channel catfish were the predominant fish in the impingement collections.

Diatoms were usually the most abundant phytoplankton components in the 1980 entrainment samples. Phytoplankton biomass in terms of chlorophyll a content ranged from 7.367 to 62.7 mg/m^3, and was greatest on the November sampling date. Zooplankton densities for entrainment sampling ranged from 1,814 to 82,000 organisms/m^3 and were considerably larger than during 1979. Rotifers dominated the zooplankton community on each sampling date. Ichthyoplankton entrainment samples collected during 1980 were void of fish larvae and eggs. The small percentage of the total river flow entering the station indicated that the impact of DAEC on the phytoplankton, zooplankton and ichthyoplankton communities as a result of entrainment was minimal.

The terrestrial vegetation monitoring during May through September 1980 revealed no evidence of salt damage resulting from the operation of the station cooling towers.

Chapter 1

Introduction

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

An ecological monitoring program was conducted for the Iowa Electric Light and Power Company in the vicinity of the Duane Arnold Energy Center (DAEC) near Palo, Iowa from January through December 1980. Physical, chemical, and biological studies were conducted in the Cedar River, and terrestrial studies were carried out near the station to meet the requirements of Section 4.0, "Environmental Surveillance and Special Studies," of the Nuclear Regulatory Commission's Technical Specifications. Data collected as part of this monitoring program were utilized to evaluate the operational impact of the DAEC generating facility on the ecology of the Cedar River and the nearby terrestrial vegetation during 1980.

Studies to determine the baseline physical, chemical, and biological characteristics of the Cedar River near the Duane Arnold Energy Center were instituted in April 1971 prior to station start-up. Data from these studies served as a basis for the development of the operational monitoring program which was implemented in January 1974 and has continued to date.

1.1 OBJECTIVES OF THE STUDY

The operational studies were designed to identify and evaluate any substantial effects of chemical or thermal discharges from the generating station on the Cedar River aquatic ecosystem as well as to determine the magnitude of impingement on intake screens and entrainment in the condenser make-up water.

The specific objectives of the operational study were threefold:

1. To continue routine water quality and biological determinations in the Cedar River upstream from the discharge canal in order to identify ambient conditions and to describe natural variations in water quality and biological communities;

2. To conduct physical, chemical and biological studies in and downstream from the discharge canal to define possible water quality changes occurring as the result of chemical additions or condenser passage and to identify the potential impact of the station effluent on aquatic communities of the Cedar River; and

3. To identify and quantify organisms impinged on the intake screens and entrained in the intake water in order to estimate the magnitude and effects of impingement and entrainment.

1.2 DESCRIPTION OF THE STUDY SITE

The Duane Arnold Energy Center is a nuclear fueled electrical generating plant operated by the Iowa Electric Light and Power Company. The facility is located on the western shore of the Cedar River, about 2.5 mi north-northeast of Palo, Iowa in Linn County. A boiling water nuclear power reactor is used to produce about 550 MWe of power at full capacity. Circulating condenser water from the turbine cycle is cooled by means of two closed loop induced

draft cooling towers, which require a maximum of 11,000 gpm of water from the Cedar River. A maximum of 7,000 gpm may be lost through evaporation, while 4,000 gpm is returned to the river as blowdown water.

Sampling sites for the operational monitoring program have been established in the discharge canal and at four locations in the Cedar River (Figure 1-1): Location 1 is upstream of the station at the Lewis Access Bridge; Location 2 is immediately upstream from the station intake; Location 3 is approximately 140 ft downstream of the station discharge; and Location 4 is adjacent to Comp Farm about 0.5 mi downstream from the station. Samples also were collected from Location 5 in the discharge canal. Impingement and entrainment samples were collected in or near the station intake.

1.3 MONITORING FREQUENCY

The monitoring frequency for each aspect of the program is presented in Table 1-1. Samples for general chemical and plankton analysis were collected semi-monthly, whereas samples for seasonal chemical analysis, periphyton, benthos, and fishery studies were collected three times per year. Impingement/entrainment studies were conducted quarterly and were representative of the four seasons. Five vegetation inspections were made from May through September 1980. Thermal plume mapping was not conducted during 1980 because the river flow continuously exceeded the minimum specified for plume mapping.

1.4 CONTRACT PERFORMANCE

The studies described herein were performed by staff members and at the facilities of Ecological Analysts, Inc. (EAI). Prior to November 1980, the staff was employed by Hazleton Environmental Sciences Corporation, Northbrook, Illinois. In late October 1980, Hazleton and EAI reached an agreement whereby certain assets and contracts of Hazleton were acquired by EAI. Through this agreement, EAI assumed responsibility for the Duane Arnold Energy Center non-radiological environmental monitoring program. Although the name of the contracting organization changed, the staff and facilities where the work was performed remained essentially intact. The only change involved water quality analyses; beginning with the samples collected on 20 November 1980, analyses were performed in EAI's laboratory in Sparks, Maryland, rather than in Hazleton's laboratory in Northbrook, Illinois.

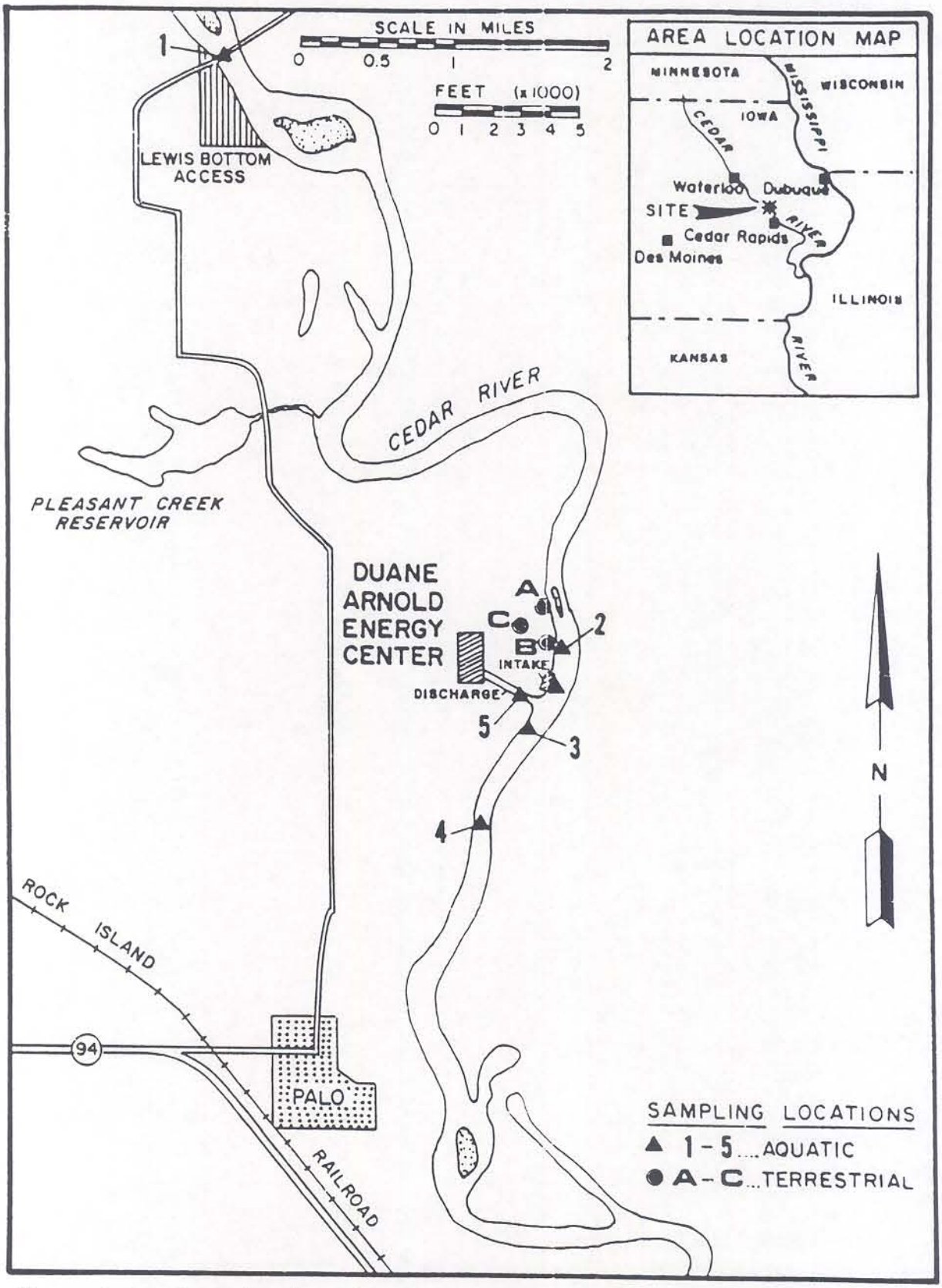

Figure 1-1. Sampling locations for the Cedar River operational monitoring study near Duane Arnold Energy Center, January - December 1980.

TABLE 1-1 MONITORING FREQUENCY FOR THE DUANE ARNOLD ENERGY CENTER ECOLOGICAL STUDY, JANUARY - DECEMBER 1980

Program Aspect	Month of Collection											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
General Water Quality Analyses	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
Seasonal Water Quality Analyses					X				X		X	
Phytoplankton	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
Periphyton					X				X		X	
Benthic Macroinvertebrates												
Natural Substrates					X				X		X	
Artificial Substrates					X				X		X	
Fisheries					X				X		X	
Fish Basket Study									X			
Impingement		X			X				X		X	
Entrainment		X			X				X		X	
Radiological												
Periphyton		X			X				X		X	
Fish					X						X	
Bottom Sediments					X						X	
Terrestrial					X	X	X	X	X			

Chapter 6

Impingement/Entrainment

CONTENTS

LIST OF TABLES

6.0 IMPINGEMENT/ENTRAINMENT

6.1 INTRODUCTION

A fish impingement study was conducted at the Duane Arnold Energy Center (DAEC) from January to December 1980, as part of the operational environmental monitoring program that has been conducted continuously since 1974. In addition, phytoplankton, zooplankton and ichthyoplankton were sampled to determine the extent of entrainment of these organisms by the DAEC. The specific objectives of the study were:

1. to identify the occurrence and number of adult and juvenile fish impinged on the station's intake screens;
2. to assess the impingement rates of fish at the Duane Arnold Energy Center;
3. to estimate the phytoplankton, zooplankton, and ichthyoplankton species composition and abundance at the intake location;
4. to estimate the phytoplankton biomass in terms of milligrams of chlorophyll a per cubic meter of water at the intake location; and
5. to relate the above data to the volume of water entering the plant.

6.2 HISTORICAL REVIEW

Impingement studies were initiated at DAEC in 1974. Only two trash basket counts were made the first year of sampling (McDonald 1975). From 1975 through 1979, impinged fish were counted daily, and on four dates each year impinged fish were identified and their lengths and weights recorded (McDonald 1976, 1977, 1978, 1979; Jovanovic and Alberico 1980). Impingement during the 1975 through 1979 study period was low, ranging from 104 to 651 fish per year. The majority of fish identified on four sampling dates during each of those four years were young-of-the-year channnel catfish.

Entrainment studies have been conducted at DAEC since 1974. Phytoplankton, zooplankton, and ichthyoplankton samples were collected at the intake structure on three dates each in 1974 and 1975, and on four dates each in 1976, 1977, 1978, and 1979 (McDonald 1975, 1976, 1977, 1978, 1979; Jovanovic and Alberico 1980). Phytoplankton and zooplankton densities were reported in different units from year to year, therefore making comparisons among the years difficult.

Phytoplankton densities were lowest during the February or March sampling of each year, and were usually highest during the August or October sampling of each year. The lowest phytoplankton densities were recorded during February 1979 (275 units/ml), and the highest densities (1,134,000 units/ml) occurred during October 1974. Diatoms were usually more abundant than any of the other phytoplankton divisions (McDonald 1975, 1976, 1977, 1978, 1979; Jovanovic and Alberico 1980).

There was no consistency among months in the highest and lowest zooplankton densities observed during 1974-1978. Mean yearly zooplankton densities were greatest in 1979 (23,685 organisms/m^3) and lowest in 1978 (318/m^3). Rotifers were usually more abundant than any other major zooplankton group (McDonald 1975, 1976, 1977, 1978, 1979; Jovanovic and Alberico 1980).

Ichthyoplankton samples were void of organisms in 1974, 1975 and 1977. Only three fish eggs were collected in 1976 (May 11), and only cyprinid larvae were collected in 1978 (July 31) (McDonald 1975, 1976, 1977, 1978, 1979). A total of 12 fish larvae were collected in 1979; 11 catostomids in May and one carp (Cyprinus carpio) in August (Jovanovic and Alberico 1980).

The volume of water drawn into the station for condenser cooling is 24.5 cfs. This volume represents a variable percentage of the total river flow depending on the river discharge on any particular date. Historically, the percentage of river flow entering the station was highest during the February 1977 sampling date (6.0%). Because the percentage has always been small, phytoplankton, zooplankton, and ichthyoplankton entrainment was never considered to be a significant problem at the DAEC (McDonald 1975, 1976, 1977, 1978, 1979; Jovanovic and Alberico 1980).

6.3 FIELD AND ANALYTICAL PROCEDURES

6.3.1 Impingement

Daily counts of fish collected in the trash baskets at the station's intake were made by station personnel from January through December 1980. Each daily count represented the number of fish impinged over a 24-hour period. On four sampling dates (20 February, 19 May, 4 September, and 19 November) 24-hour trash basket counts were made by EA personnel. The fish collected on those four dates were identified to the lowest possible taxonomic level and their individual lengths (millimeters) and weights (grams) were recorded.

6.3.2 Entrainment

6.3.2.1 Field Procedures

Single samples to determine the species composition and abundance of entrained phytoplankton, and chlorophyll a concentration were collected from the intake location (Figure 1-1, Chapter 1) on 20 and 21 February, 20 and 21 May, 4 September and 19 November 1980 using a 6 liter Kemmerer or Van Dorn water sampler. Samples for phytoplankton species composition and abundance were placed into 1.9 liter polyethylene bottles, preserved at the time of collection with 1.0% Lugol's solution and transported to the laboratory for analysis. Samples for phytoplankton chlorophyll a analyses were placed into 3.8 liter cubitainers, iced, and transported to the laboratory unpreserved.

Single samples to determine the species composition and abundance of entrained zooplankton were collected from the intake location on 21 February, 21 May, 3 September and 19 November 1980 by placing a 30 cm diameter, No. 25 mesh (64 μm aperture), conical plankton net horizontally in the current of the river for a measured length of time. The river current was also measured in

conjunction with the collection of the zooplankton sample. The zooplankton samples were placed in glass jars, and immediately anesthetized with menthol crystals which relax the body structure of the Rotifera thereby facilitating identification. Within a few hours of collection, the samples were preserved with 5% formalin, and transported to the laboratory for analysis.

Ichthyoplankton entrainment sampling was conducted quarterly (20 February, 20 May, 3 September and 19 November). Samples were collected in the river adjacent to the intake bar grill using a 0.5 m diameter conical plankton net with a mesh aperture of 571 µm (No. 0 mesh). The net was held stationary in a horizontal position and allowed to sample for 5-10 minutes.

Two samples were obtained for each sampling period; one collected within 1 m of the surface, and the other collected within 1 m of the bottom. A General Oceanics Model 2030 digital flow meter was mounted in the center of the net mouth to determine the volume of water filtered. In addition, a Marsh-McBirney Model 20 electromagnetic current meter was used to measure current velocity at the intake at the time of sampling. Surface water temperatures were recorded prior to sampling using a Whitney Model TC-5A thermistor. Samples were preserved in formalin and transported to the laboratory for analysis.

6.3.2.2 Laboratory Procedures

The samples used to determine entrained phytoplankton species composition and abundance were analyzed with the inverted microscope method as described in Chapter 3.

Three subsamples were withdrawn from each unpreserved phytoplankton sample and analyzed for chlorophyll a content. Each subsample was filtered through Whatman GF/C glass fiber filters on a thin layer of $MgCO_3$, eluted for at least 24 hours with 90% acetone, and subjected to ultrasonic disruption. The subsamples were then centrifuged and their fluorescence determined before and after the addition of 1 N HCl (Lorenzen 1966). The general equation of Strickland and Parsons (1972) was used to calculate the chlorophyll a concentration in milligrams per cubic meter of water (mg/m^3).

The samples for determining species composition and abundance of entrained zooplankton were analyzed using a subsampling and stratified counting technique. The samples were first concentrated or diluted so there was a suitable working density of organisms in a 1 to 5 ml subsample. A minimum of two subsamples, yielding at least 300 organisms, were analyzed per sample. Subsamples were placed in a Bogorov counting chamber and examined with a Bausch and Lomb stereozoom dissection microscope at 10-70X magnification. Any organisms which were difficult to identify were removed from the counting chamber and mounted on glass slides for further examination using a Leitz SM Lux research microscope.

All Crustacea were identified to species with the exception of immature copepods which were categorized as nauplii, calanoid copepodites or cyclopoid copepodites. Unidentifiable immature forms of daphnids were identified

to genus. All Rotifera were identified to genus with the exception of the rotifers of Class Bdelloidea, which when preserved with formalin, are usually identifiable only to class. Identifications were made using current appropriate taxonomic keys.

Ichthyoplankton samples were placed in a white enamel pan and examined for fish eggs and larvae under a magnifying lens equipped with a fluorescent light. Specimens were not found in any of the samples; therefore, no other analytical procedures were necessary.

6.4 RESULTS AND DISCUSSION

6.4.1 Impingement

A total of 230 fish were impinged during 1980 at the Duane Arnold Energy Center (Table 6-1). The highest impingement rates occurred in the winter months, particularly January and February, when 84 and 71 fish were impinged, respectively. Few fish were impinged throughout the spring, summer and fall with monthly impingement ranging from zero to 15 fish.

On four scheduled dates, EA personnel performed the impingement sampling and analyzed the impinged fish. The fish collected on each date represented those impinged over a 24-hour period. All of the 29 impinged fish observed by EA personnel during this study were collected on 20 February. Of these, 17 were small channel catfish (probably yearlings) and the rest were various minnow species (Table 6-2). No fish were impinged on the other three sampling dates.

6.4.2 Entrainment

Densities of total phytoplankton increased from February to a maximum in May (126,000 units/ml) (Table 6-3). The peak abundance reported in 1979 was only 27,000 units/ml (Jovanovic and Alberico 1980); further comparisons were impossible because there was no data for the other two 1979 sampling dates. Diatoms dominated the community in all sampling months, except in September when they were over-shadowed by blue-greens. The centric diatom, Stephanodiscus invisitatus, was abundant throughout the study period, and composed over 78% of the total phytoplankton in November. The major constituent of the September community was the blue-green, Aphanizomenon flos-aquae, which is characteristic of eutrophic lakes or polluted, hard water, slow-flowing streams (Prescott 1962).

Phytoplankton chlorophyll a concentrations ranged from 7.367 mg/m^3 in February to 62.7 mg/m^3 in November (Table 6-4). Concentrations of chlorophyll a in 1979 varied from 0.593 mg/m^3 to 129.54 mg/m^3.

The highest observed zooplankton densities at the intake location occurred in May (82,000 organisms/m^3). The lowest densities occurred in November (1,814 organisms/m^3) when populations typically decline in response to reduced water temperatures and other abiotic factors (Table 6-5). Rotifers dominated the community in all months, composing at least 67% of the total zooplankton. The previous year's study also documented the abundance of rotifers (Jovanovic and Alberico 1980). The most abundant rotifer taxa were

TABLE 6-1 DAILY NUMBERS OF FISH IMPINGED AT THE DUANE ARNOLD ENERGY CENTER, JANUARY-DECEMBER 1980

Day of the Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0	0	0	0	0	1	0	0	0	0	0	0	1
2	0	6	0	0	1	0	0	1	0	0	0	0	8
3	17	0	0	0	0	0	0	0	4	1	0	7	29
4	5	6	0	0	0	0	0	0	0(a)	0	1	0	12
5	8	0	0	0	0	0	0	0	0	0	0	1	9
6	3	0	0	0	0	0	0	0	0	0	0	3	6
7	0	16	0	0	0	0	0	0	0	0	0	5	21
8	0	4	0	0	0	0	0	0	0	0	0	3	7
9	26	0	0	0	0	0	0	0	0	0	2	0	28
10	0	0	0	0	0	0	0	0	0	1	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	1	0	1	2
13	16	0	0	0	0	0	0	0	0	0	0	0	16
14	0	0	0	0	0	2	0	0	1	2	1	0	6
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	6	0	0	0	0	0	1	0	7
19	0	0	0	0	0(a)	0	0	0	0	0	0(a)	0	0
20	0	29(a)	0	0	0	0	0	0	0	0	0	0	29
21	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	2	1	0	0	0	3
24	0	10	0	2	0	0	0	0	0	0	4	0	16
25	0	0	0	1	0	1	0	1	0	0	3	0	6
26	9	0	0	1	0	1	0	1	0	0	1	4	17
27	0	0	0	0	0	0	0	0	0	0	1	1	2
28	0	0	0	1	0	0	0	1	0	0	0	0	2
29	0	0	0	0	0	0	0	0	0	0	1	1	2
30	0		0	0	0	0	0	0	0	0	0	0	0
31	0		0		0		0	0			0		0
Total	84	71	0	5	7	5	0	6	6	5	15	26	230

(a) Dates that impingement collections were made by EA personnel.

TABLE 6-2 SPECIES COMPOSITION AND SIZE DISTRIBUTION OF IMPINGED FISH ANALYZED QUARTERLY DURING 1980

Date and Species	Number	Total Length (mm) Mean	Total Length (mm) Range	Weight (g) Mean	Weight (g) Range
20 February					
Channel catfish	17	62	41-112	2.3	0.5-11.0
Spotfin shiner	7	60	44-77	2.1	0.5-5.0
Sand shiner	3	52	42-60	0.7	0.5-1.0
Bigmouth shiner	1	60	-	1.0	-
Bluntnose minnow	1	57	-	2.0	-
19 May					
No fish impinged					
4 September					
No fish impinged					
19 November					
No fish impinged					

TABLE 6-3 DENSITY AND PERCENT OCCURRENCE OF DOMINANT (>5%) TAXA, MAJOR DIVISIONS AND TOTAL PHYTOPLANKTON COLLECTED QUARTERLY FROM THE CEDAR RIVER AT THE INTAKE LOCATION OF THE DUANE ARNOLD ENERGY CENTER, 1980

Taxa	21 February		21 May		4 September		19 November	
	Units/ml	%	Units/ml	%	Units/ml	%	Units/ml	%
Asterionella formosa	41	15.0	0	0.0	0	0.0	0	0.0
Cyclotella meneghiniana	9	3.4	3740	3.0	571	5.4	53	0.8
Melosira granulata	0	0.0	0	0.0	693	6.6	27	0.4
Nitzschia dissipata	33	11.9	187	0.2	35	0.3	11	0.2
Skeletonema potamos	3	1.0	0	0.0	537	5.1	91	1.4
Stephanodiscus invisitatus	79	28.6	35904	28.4	433	4.1	5247	78.5
Stephanodiscus tenuis	0	0.0	13277	10.5	0	0.0	0	0.0
Total Bacillariophyta	237	86.1	64889	51.2	3463	32.8	6021	90.1
Micractinium quadrisetum	0	0.0	17017	13.4	0	0.0	0	0.0
Actinastrum hantzschii var. *fluviatile*	0	0.0	14913	11.8	0	0.0	0	0.0
Total Chlorophyta	10	3.7	55212	43.6	628	5.9	302	4.5
Aphanizomenon flos-aquae	0	0.0	0	0.0	4867	46.1	46	0.7
Coelosphaerium naegelianum	0	0.0	0	0.0	554	5.3	0	0.0
Total Cyanophyta	0	0.0	3160	2.5	6161	58.3	315	4.7
Total Chrysophyta	21	7.5	0	0.0	52	0.5	16	0.2
Total Euglenophyta	2	0.7	1122	0.9	139	1.3	11	0.2
Total Cryptophyta	6	2.0	2244	1.8	121	1.2	16	0.2
Total Phytoplankton	275		126627		10563		6681	

TABL

TABLE 6-4 QUARTERLY CHLOROPHYLL a CONCENTRATIONS (mg/m^3) FROM SAMPLES COLLECTED IN THE CEDAR RIVER AT THE INTAKE OF THE DUANE ARNOLD ENERGY CENTER, 1980

Location	Rep	20 February	20 May	4 September	19 November
Intake	1	6.967	23.063	14.607	65.601
	2	6.727	31.711	20.053	57.518
	3	8.408	29.789	17.458	64.980
	Mean	7.367	28.188	17.373	62.700

TABLE 6-5 MEAN ABUNDANCE AND PERCENT OCCURRENCE OF ZOOPLANKTON IDENTIFIED FROM ENTRAINMENT SAMPLES COLLECTED QUARTERLY IN THE CEDAR RIVER NEAR THE DUANE ARNOLD ENERGY CENTER, 1980

	20 February		20 May		3 September		19 November	
	No./m^3	%	No./m^3	%	No./m^3	%	No./m^3	%
nauplii	1392	22.62	835	1.01	1146	25.60	249	13.71
calanoid copepodites	5	0.08	0	0	2	0.04	0	0
cyclopoid copepodites	356	5.79	104	0.13	53	1.18	26	1.43
Cyclops bicuspidatus thomasi	38	0.61	0	0	0	0	0	0
Cyclops vernalis	9	0.15	0	0	10	0.22	0	0
Diaptomus sicilis	9	0.15	0	0	0	0	0	0
Diaptomus siciloides	0	0	0	0	2	0.04	0	0
Eucyclops agilis	5	0.08	0	0	0	0	0	0
Eucyclops speratus	5	0.08	0	0	0	0	0	0
Tropocyclops prasinus mexicanus	9	0.15	0	0	0	0	0	0
TOTAL COPEPODA	1828	29.70	939	1.14	1213	27.10	275	15.14
Alona guttata	5	0.08	0	0	0	0	0	0
Bosmina longirostris	70	1.14	0	0	4	0.09	5	0.29
Chydorus sphaericus	52	0.84	0	0	0	0	0	0
Daphnia galeata mendotae	19	0.30	0	0	0	0	0	0
Daphnia sp. (immature)	5	0.08	0	0	0	0	0	0
TOTAL CLADOCERA	151	2.44	0	0	4	0.09	5	0.29
Bdelloid Rotifera	120	1.95	2465	2.99	466	10.41	111	6.10
Brachionus spp.	2390	38.82	70124	85.21	680	15.19	235	12.95
Cephalodella spp.	0	0	1552	1.89	0	0	97	5.33
Collotheca spp.	0	0	0	0	0	0	14	0.76
Euchlanis spp.	0	0	1096	1.33	18	0.40	28	1.52
Filinia spp.	103	1.68	183	0.22	53	1.18	0	0
Kellicottia spp.	17	0.28	0	0	0	0	0	0
Keratella spp.	103	0.68	3561	4.33	913	20.40	97	5.33
Lecane spp.	0	0	0	0	18	0.40	0	0
Monostyla spp.	0	0	0	0	72	1.61	0	0
Notholca spp.	928	15.08	0	0	0	0	0	0
Polyarthra spp.	361	5.86	91	0.11	72	1.61	359	19.81
Pompholyx spp.	0	0	0	0	824	18.41	0	0
Synchaeta spp.	155	2.51	1644	2.00	107	2.39	581	32.00
Testudinella spp.	0	0	0	0	18	0.40	0	0
Trichocerca spp.	0	0	0	0	18	0.40	0	0
Trichotria spp.	0	0	639	0.78	0	0	14	0.76
TOTAL ROTIFERA	4177	67.86	81355	98.86	3259	72.81	1534	84.57
TOTAL ZOOPLANKTON	6156		82294		4476		1814	

Brachionus, Keratella, Pompholyx, and Synchaeta. Immature copepods accounted for the majority of the crustaceans.

No ichthyoplankton (fish eggs and larvae) were collected during the quarterly sampling program. The seasonal occurrence of ichthyoplankton in the drift, reported by Latvaitis (1976) for the Mississippi River and Bliss (1977) for the Missouri River, was from April through August with a peak density in June and July. Therefore, it is probable that only one or two sampling periods coincided with the reproduction and early life history periods of fish species inhabiting the Cedar River. Consequently, the data provided little insight into the seasonal occurrence and abundance of ichthyoplankton or possible entrainment effects on the fish community.

The percentage of the total river flow entering the plant on each of the entrainment sampling dates of 1980 is presented in Table 6-6. The highest percentage recorded during 1980 was 1.33% in February. Therefore, there is little likelihood that entrainment at the Duane Arnold Energy Center affected the phytoplankton, zooplankton or ichthyoplankton populations of the river on the scheduled sampling dates.

6.5 SUMMARY AND CONCLUSIONS

1. Fish impingement rates at the Duane Arnold Energy Center were low throughout 1980. Only 230 fish were impinged during the year with most of the impingement occurring during the winter. Based on these low numbers, impingement by the plant had no appreciable impact on fish populations in the river during 1980.

2. Phytoplankton densities at the intake location reached a maximum of 126,000 units/ml in May. Diatoms dominated the community in all sampling months except September when blue-green algae composed over half of the total phytoplankton.

3. Phytoplankton biomass in terms of chlorophyll *a* content ranged from 7.367 to 62.7 mg/m3, and was particularly high on the November sampling date.

4. Zooplankton densities ranged from 1,814 to 82,000 organisms/m3. These densities were higher than those reported in the 1979 study period. The zooplankton community was dominated by rotifers on every sampling date.

5. No fish eggs or larvae were collected during the entrainment sampling.

6. Phytoplankton and zooplankton populations in the Cedar River were probably not affected by entrainment at the Duane Arnold Energy Center.

7. The ichthyoplankton data obtained during the present study were insufficent to assess entrainment impact, however, based on the low percentage of river water utilized by the station for cooling purposes, the level of impact was probably minimal.

TABLE 6-6 PERCENTAGE OF TOTAL CEDAR RIVER FLOW ENTERING THE DUANE ARNOLD ENERGY CENTER ON THE ENTRAINMENT SAMPLING DATES, 1980

Date	River Flow at Cedar Rapids (cfs)[a]	Percent Entering Plant
February 20	1840	1.33
February 21	1990	1.23
May 20	2060	1.19
May 21	2110	1.16
September 4	8830	0.28
November 19	2400	1.02

(a) Data for the Cedar River at Cedar Rapids, Iowa obtained from U.S. Geological Survey, Iowa City, Iowa.

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